



# United States Department of the Interior

## U. S. GEOLOGICAL SURVEY

Idaho Water Science Center

203 Collins Rd

Boise, Idaho 83702

January 8, 2010

Diana M. Eignor,  
USEPA/Office of Water/Office of Science and Technology  
1200 Pennsylvania Ave., N.W., MC 4304T  
Washington, DC 20460

Subject: Nutrient enrichment effects in streams in the upper Snake River basin: Preliminary results  
(EPA-USGS IAG#DW-14-922244201-0)

Dear Ms. Eignor:

In consultation with the Idaho Department of Environmental Quality (IDEQ), the U.S. Environmental Protection Agency's (EPA) Ecological and Health Processes Branch of the Office of Science and Technology/OW entered into an interagency agreement (IAG) with the U.S. Geological Survey (USGS) to provide funding to enhance stream and river monitoring for nutrients and associated ecological effects. The augmented funding was intended by EPA to help IDEQ develop data necessary to make decisions relative to nutrient criteria. The funding was used for enhanced analyses that complemented and improved the explanatory power of a USGS field study of nutrient enrichment effects in Idaho that was conducted in 2007 and 2008.

I would like to provide a provisional summary of results of the studies that were made possible by the subject agreement. The project's statement of work did not include any specific reporting of the results to EPA because the results were expected to be incorporated into broader analyses of nutrient enrichment effects of stream ecosystems in the upper Snake River basin conducted as part of the USGS National Water Quality Assessment Program (NAWQA). Unfortunately, because of the numerous other planned analyses nationally, in the final decision of what interpretive reports would be supported by the NAWQA program this work was not included. My co-investigators and I believe that the studies furthered our understanding of nutrient enrichment effects and nutrient limitation, are broadly relevant, and thus would be worthwhile to publish. However, because such publication would currently be an "extracurricular" effort, we cannot promise having a completed publication by any certain date. Thus the reason for this letter – I would like provide some written account of the work that has been completed with support from this agreement and provisional results that have been previously presented at professional meetings. The attachment to this letter is based upon a slideshow presentation of results that was made to Region 10 staff in May 2009 and to the Northwest Bioassessment Workgroup in November 2009. The text is from the speaking notes from these previous presentations, and thus it is more informal than that of a formal report. Similar presentations have been proposed for different audiences at the Idaho Water Quality Monitoring Conference in Boise, February 2010, and the National Water Quality Monitoring Conference in Denver, April 2010.

The general theme of the effort supported by the IAG funding was to attempt better understand ecological effects associated with nutrient enrichment. Growth of phytoplankton, periphyton, and a macrophyte were tested in controlled laboratory and *in situ* nutrient limitation experiments and compared with contemporaneous detailed field observations that were being made through the NAWQA surveys. A secondary goal was to try to identify thresholds for increased growth responses to nutrient enrichment. At six sites, laboratory nutrient limitation studies were completed using a phytoplankton, the green algae *Pseudokirchneriella subcapitata* (formerly known as *Selenastrum capricornutum*); at two sites, laboratory nutrient enrichment and limitation studies using a macrophyte (duckweed, *Lemna minor*) and epiphytic periphyton were carried out; and at eight sites, *in situ* nutrient limitation experiments were conducted using nutrient diffusing substrates. Comparisons of benthic algae variability on natural and artificial substrates were also made.

This work was accomplished through collaborative efforts and funding agreements with the Idaho State University's Stream Ecology Center, Pocatello as well as through a contract with a private testing laboratory, GEI Consultants, Littleton, Colorado.

My preliminary evaluation of the results includes the following observations:

1. Different endpoints (e.g., phytoplankton algae, periphyton algae, and the macrophyte) tested in the same or similar waters sometimes had different limiting nutrients, however nitrogen (N) limitation or co-limitation was most common;
2. With both green algae and algae in periphyton, phosphorus (P) had no minimum response threshold. Rather in both test series, algae biomass followed an exponential growth function with increasing P concentrations up to an apparent saturation threshold of around 100 µg/L total P (TP) with no further growth increases at higher P concentrations;
3. With the macrophyte, an apparent P threshold of response for increased growth was around 50 µg/L TP and an apparent saturation threshold was around 100 µg/L;
4. In the growth experiments with duckweed and epiphytic periphyton, most of the N and P in the test solutions was removed over the course of the 11-day tests. This suggests that at least in fairly oligotrophic streams, uptake of N and P may confound relations between plant biomass and nutrient concentrations in stream surveys;
5. About 40 µg/L of total P and 600 µg/L of total N corresponded with a 150 mg/kg "too-green" periphyton chlorophyll guideline suggested for nuisance aquatic growth; and
6. Integrating controlled experiments and matched biomonitoring field surveys was more informative than either approach alone.

The last point may be our most fundamental result. The USGS NAWQA program, EPA's environmental monitoring and assessment program (EMAP), and similar State field surveys of nutrients and biological conditions have had predominantly observational water quality and biomonitoring designs. In observational biomonitoring, apparent relations between plant growth, nutrients, and other environmental factors are just that, apparent. This is because they are based on strength of correlations and the influences of other correlated or confounding variables cannot be excluded. Experimental laboratory experiments in which plant growth is examined following

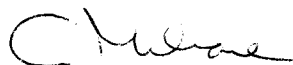
manipulation of nutrients and or other factors may avoid this problem, but are usually conducted under such artificial conditions to have uncertain direct relevance to ambient waters. We think the integrated surveys and testing provided strong information on relations between nutrients and algae relations in streams.

The attachment describes the activities and preliminary results in more detail. Again, I regret that a more formal reporting of this work remains unscheduled as I have so far been unsuccessful at locating support from within USGS to write up this material for publication. If there are ideas on ways to work towards a more formal reporting of these results, I would welcome the chance to discuss these.

In the meantime, I hope the attached materials may be informative and useful for staff discussions regarding nutrient criteria or target development. I would welcome the opportunity to discuss this or other aspects of our work related to ecological effects of nutrient enrichment streams. For instance, EPA's nutrient criteria program has led "web-cast" talks on various aspects of science and policy of nutrient criteria and management. If this work seems of interest, I would be happy to participate. Similarly, if there were interest for a conference call/web presentation specifically to EPA staff with interests in nutrient targets or effects monitoring, this would likely lead to interesting discussions.

I appreciate the opportunity to work with the EPA nutrient team on this project and look forward to further discussions. I can be reached by phone at (208) 387-1308 or email at [cmebane@usgs.gov](mailto:cmebane@usgs.gov).

Sincerely,



Chris Mebane  
Project Chief

Attachment

Cc: Terry Maret, USGS  
Greg Clark, USGS  
Steve Lipscomb, USGS,  
Michael McIntyre, IDEQ  
Jannine Jennings, EPA

